



# Navy Strategy for the Future

## Telescoping Systems Strategy for Mission Success

The US Navy and Marine Corps Corporate Laboratory

### NOGAPS: (Fleet Numerical)

- Global coverage
- 1-10d forecaster guidance

### COAMPS: (Fleet Numerical)

- High resolution, nested regional coverage
- 0-72h forecaster guidance

### DAMPS: (Regional Centers)

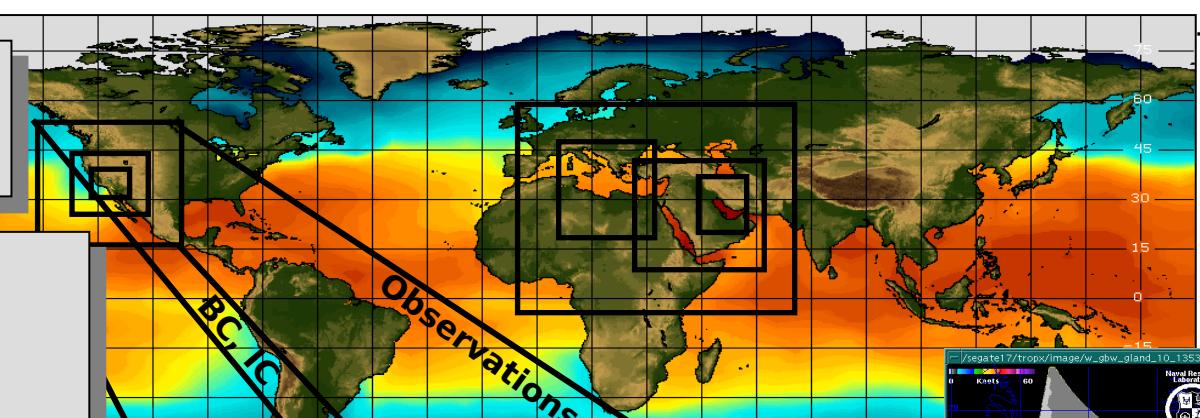
- On-scene tactical-scale weather
- 0-48h forecaster guidance
- Web enabled

### COAMPS-OS: (Shipboard-NITES)<sup>Obs</sup>

- Battlegroup data assimilation system
- 6-12h data assimilation cycle
- Web enabled

### Nowcast: (Shipboard-NITES)

- Real-time, automatic, 4D data fusion
- Warfighter time & space requirements
- Common situational awareness



BCFC

Observations

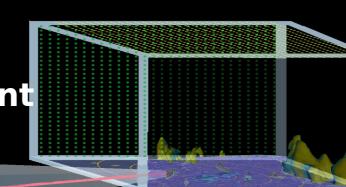
On-Scene

Obs

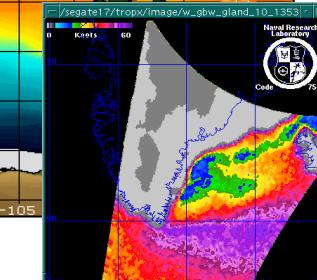
Local Model Output

Data Fusion  
AI  
Nowcast

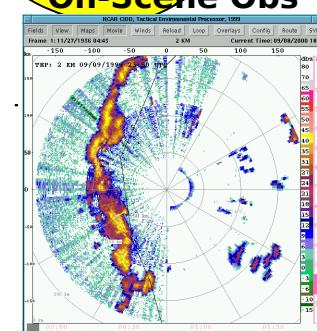
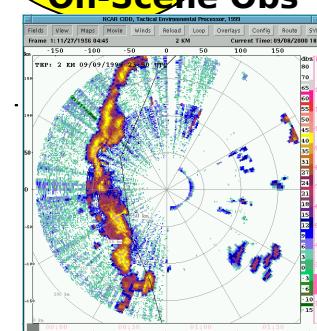
Virtual  
Natural  
Environment



TDA



On-Scene Obs





# FOR THE NEXT GENERATION NAVY **NOWCAST**

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## Core Technology Team

**Mike Frost (CSC) - Team Leader**

**Craig Kunitani (Pangaea) - Software Architect**

**Marie White (Pangaea)**

**Ramesh Mantri (CSC)**

**Jennifer Strahl (SAIC)**

## NRL

**Allen Zhao**

**Gary Love**

**Rosemary Lande**

**Larry Phegley**

**Satellite Applications Section**

**Mesoscale Modeling Section**

**Data Assimilation Section**

## Collaboration / Coordination

**NCAR**

**University of Oklahoma/NSSL**

**MIT Lincoln Labs**

## Transition Path

**SPAWAR - NITES**



## Prototype Development Progress

- Java Applet
- Java Servlets and package of servlet classes
- Package of objects shared by server and client
- Run-time database using Lightweight Directory Access Protocol (LDAP)
- Folders and tabs stored in LDAP with user context settings

## Product Development Progress

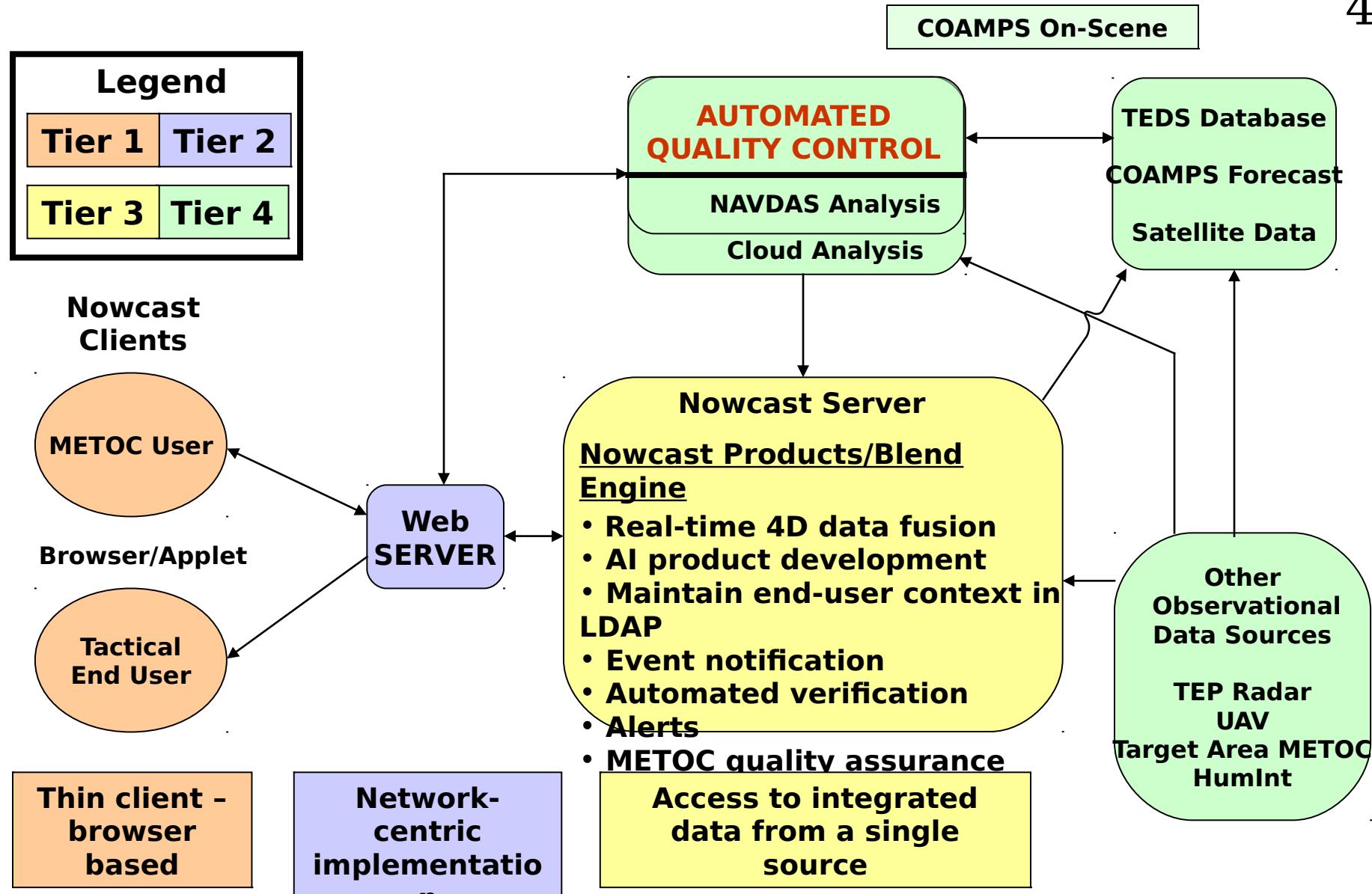
- 5 min global obs from TEDS
- 10 min radar data
- 15 min satellite data from Terascan
- NCAR C&V cycling every 15 min
- ADAS cycling hourly on COAMPS fields
- COAMPS run twice a day
- Visualization applications to generate graphical products from COAMPS, ADAS, and NCAR C&V
- Satellite interface for ADAS and NCAR C&V



# Nowcast Four-Tier Internet Architecture

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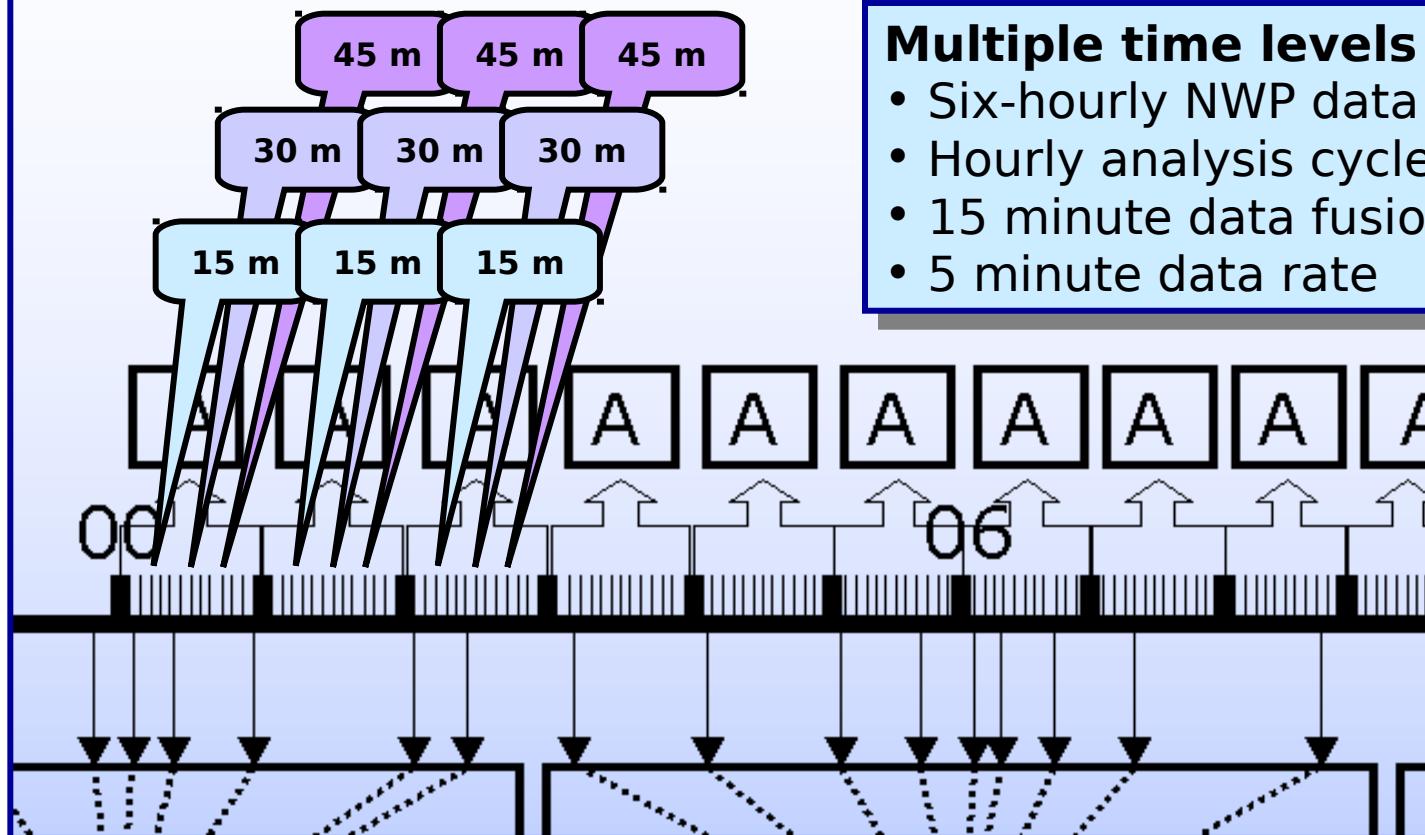


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- Use hourly analyses as background conditions
- Intermediate cycle for AI data fused product generation (approximately every 15 minutes)



## Multiple time levels

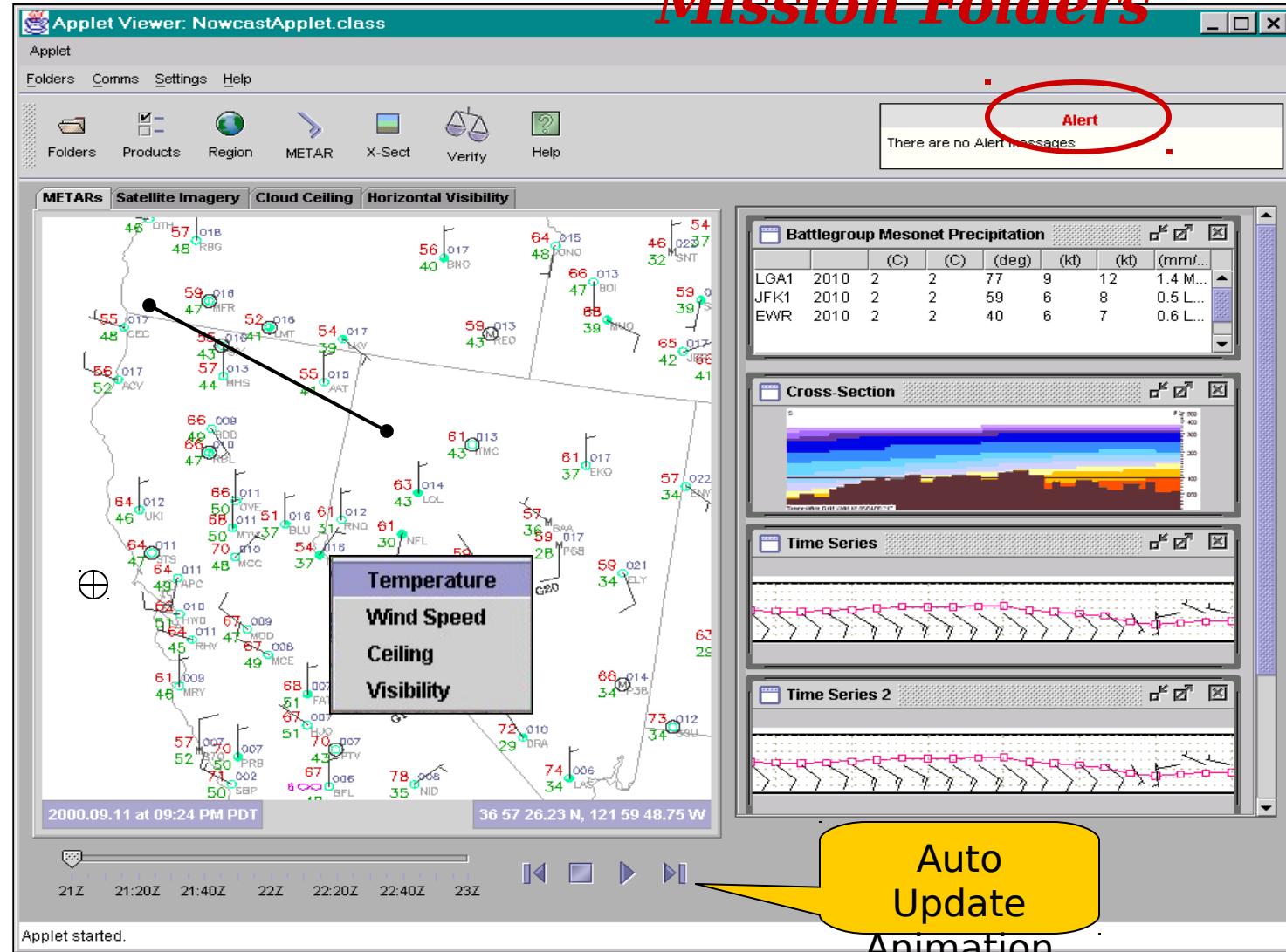
- Six-hourly NWP data assimilation cycle
- Hourly analysis cycle
- 15 minute data fusion process
- 5 minute data rate



# Nowcast Web-Based Applet Viewer

## Products Are Organized by the End User into Mission Folders

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### Air Defense Folder

- EM Propagation
- Sea State

### Strike Folder

- Winds
- Cloud Tops/Bases
- Visibility
- Icing

### TLAM Folder

- Winds/Temps Enroute
- Thunderstorms
- Sea State

### Bridge Folder

- Wind Shifts/Seas
- Thunderstorms
- Icing and Turbulence

### Pilot Folder

- Mission Rehearsal
- 3D Rendering Enroute
- Target Area Weather

### CATC Folder

- Ceiling and Visibility
- Thunderstorms

### METOC Folder

- Quality Assurance
- Alerts
- User Profiles

Tab: Region, two product layers, data, overlays

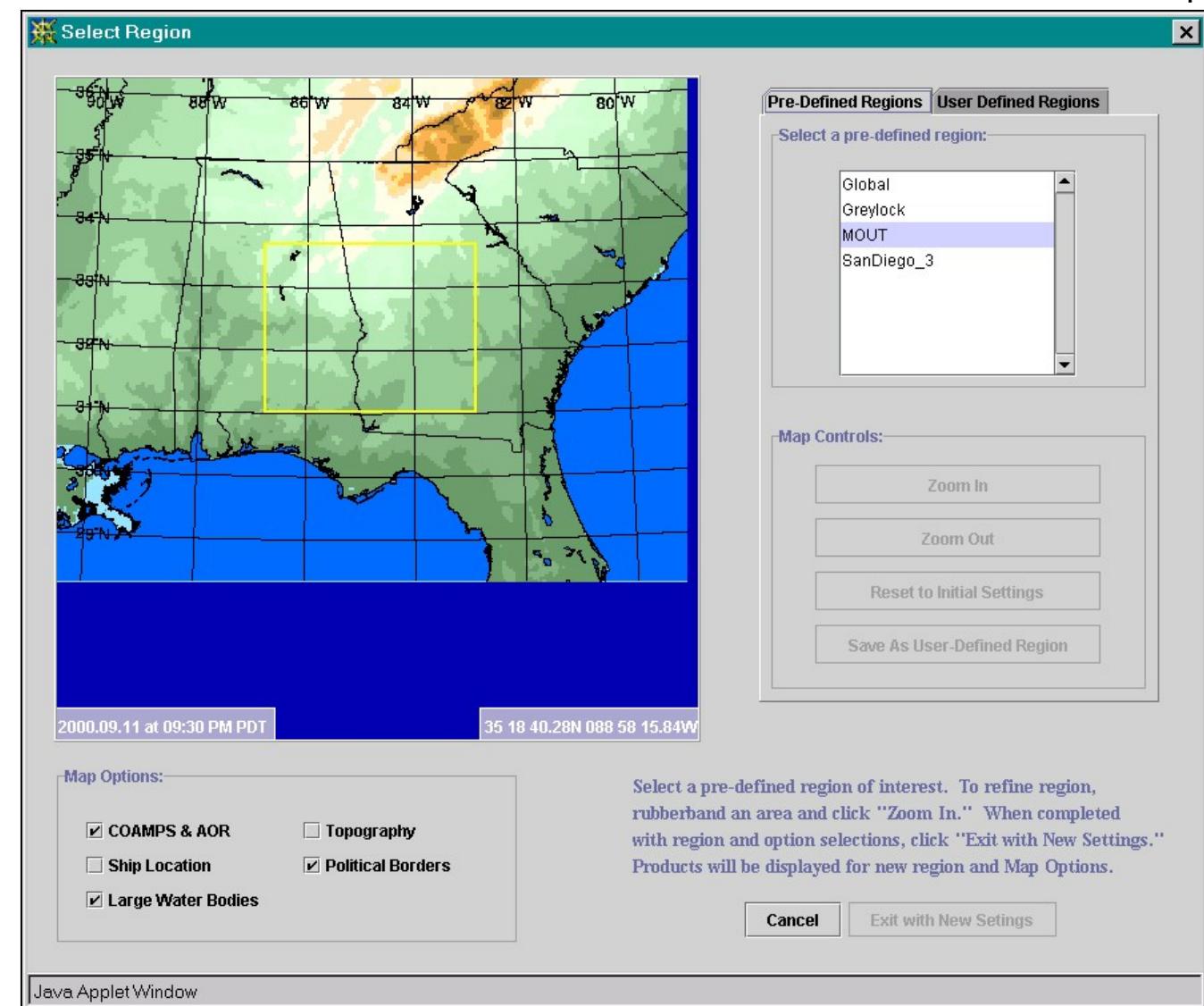


# Region Selection

## World - Tactical Views

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- Rubber band
- Zoom in / out
- Change projection
- Predefine regions
- Share maps
- Desire access to a network GIS map server
- Need bounding areas for products and data sets





# Automatic Update of Time Critical Information

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72-12 hours prior

**Directly to the End User**

6 hours

2 hours

Launch

Recovery

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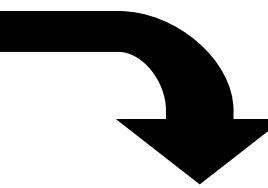
## METOC Quality Assurance

**Forecast**

**Nowcast**

*Launch site  
and  
predictions  
for specific  
targets and  
weapons*

*Up to 60 miles  
around target  
area.*



**Update**

**Preflight  
Ready room**



**Automate**



# FOR THE NEXT GENERATION NAVY

## NOWCAST

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Data	Kbits/sec	Kbits/sec (Compressed)	Data	Type	Frequency	Origin
<b>From shore to CV/CVN/AGF/LH</b>						
Conventional	0.083	(75%) 0.021	Alpha text	Continuous	Shore	
Satellite	0.356	(50%) 0.178	Binary	BUFR Continuous (30 min)	Shore	Shore
Target Area	0.226	(50%) 0.113	Binary	Continuous	Shore	
LBC (45 X 45 deg)	20.62	(50%) <u>10.31</u>	Binary GRIB	Twice a day (1 hr)	Shore	Shore
<b>Total</b>	<b>21.3</b>	<b>10.6</b>				
<b>CV/CVN/AGF/LH from all ships</b>						
Moriah	0.279	(50%) 0.140	Binary	Continuous (5 min)	All Ships	
TEP Products	56.49 214.4	(50%) 28.24 (0.0%) <u>214.4</u>	Binary	Continuous (5 min)	AEGIS Ships	
<b>Total</b>	<b>271.2</b>	<b>242.8</b>	Binary images	Continuous (5 min)	CV/CVN/AGF/LH	
<b>Individual ships (customers) except TEP equipped</b>						
Moriah/10	0.028	(50%) 0.014				
Products/10	<u>21.44</u>	(0.0%) <u>21.44</u>				
<b>Total</b>	<b>21.5</b>	<b>21.5</b>				
<b>TEP equipped ships</b>						
TEP	56.49	(50%) 28.24				
Moriah/10	0.028	(50%) 0.014				
Products/10	<u>21.44</u>	(0.0%) <u>21.44</u>				
<b>Total</b>	<b>78.0</b>	<b>49.7</b>				

**COAMPS-OS Estimates**  
10.6 kbits/sec (compressed)  
to large ships twice a day for 1 hour duration

**Nowcast Estimates**  
Large ships - 242.8 kbits/sec  
Small ship - 21.5 kbits/sec  
TEP ships - 49.7 kbits/sec



# FOR THE NEXT GENERATION NAVY

## NOWCAST

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- ① Horizontal Visibility, Cloud Ceiling, and Flight Category
- ① Temperature, Humidity, Precipitation Intensity, and Heat Index
- ① Low-Level Winds and Winds Aloft
- ① Density Altitude and Altimeter Setting
- ① Cloud Location, Top, Base, Layers and Fraction

- ② Composite Radar/Satellite Storm Animation
- ② Thunderstorm Autonowcaster
- ② Storm Cell Location, Movement and Intensity
- ② “Stoplight” Operational Decision Matrix
- ② Electromagnetic Duct Height and Propagation Conditions

- ③ Wind Shear and Microburst
- ③ Extent of In-Flight Icing
- ③ Extent of In-Flight Turbulence

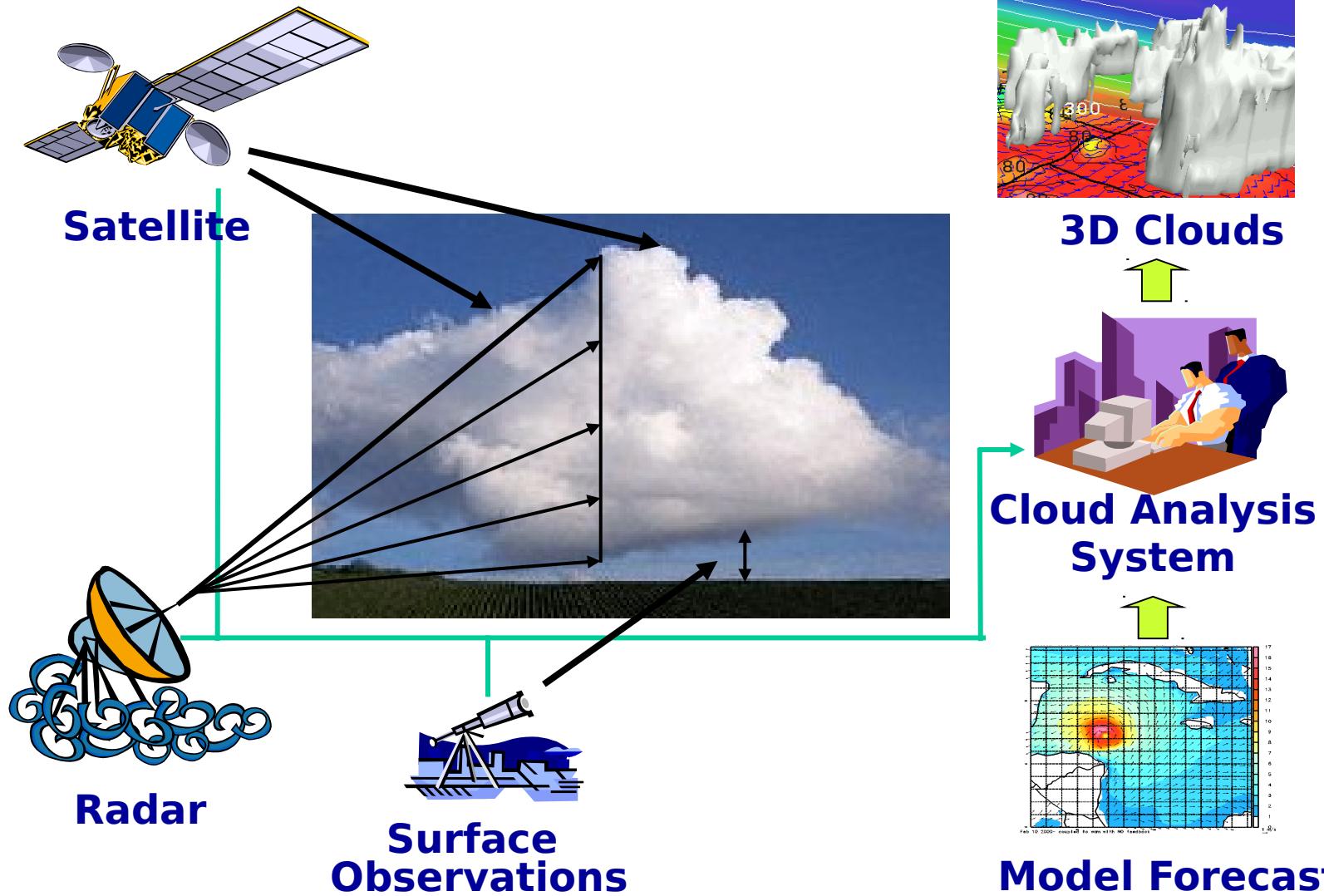


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## ADAS Cloud Analysis System

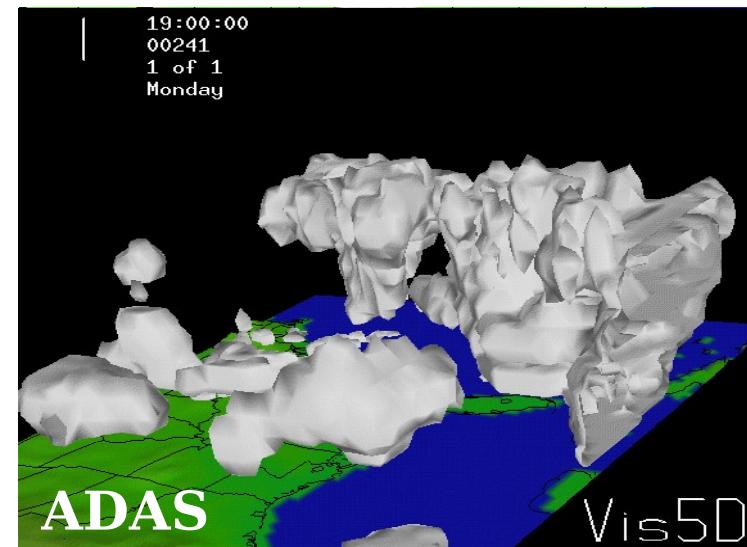
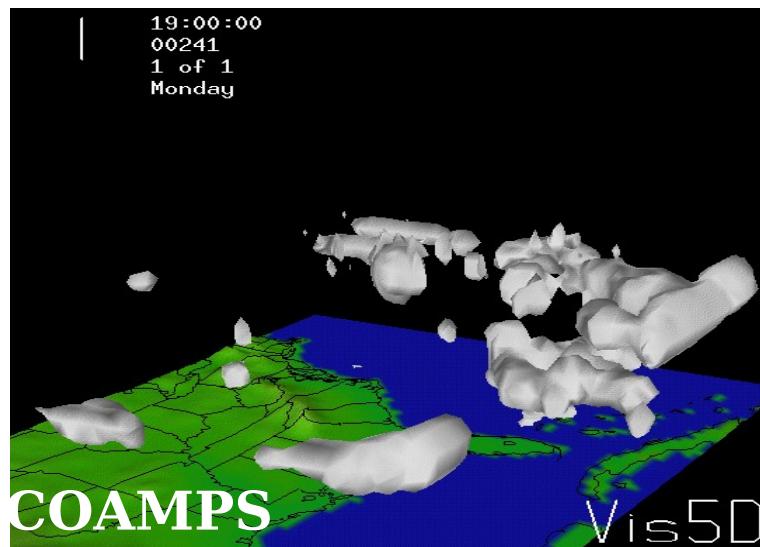
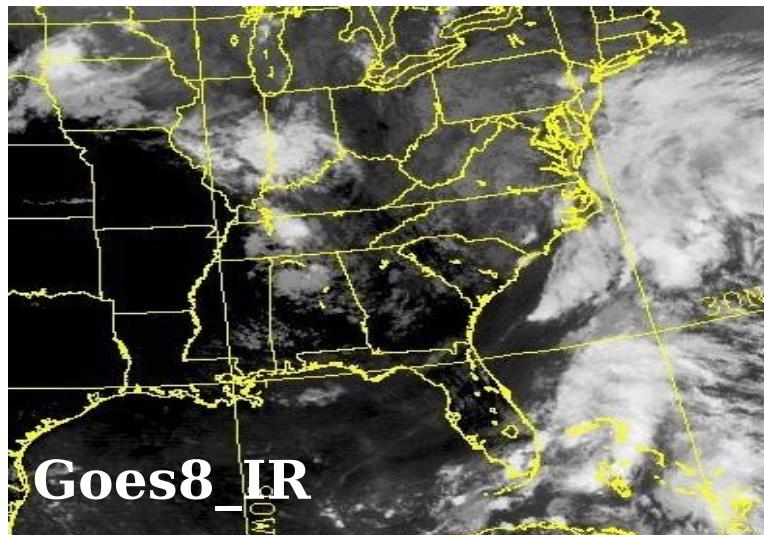




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19Z 28 August 2000



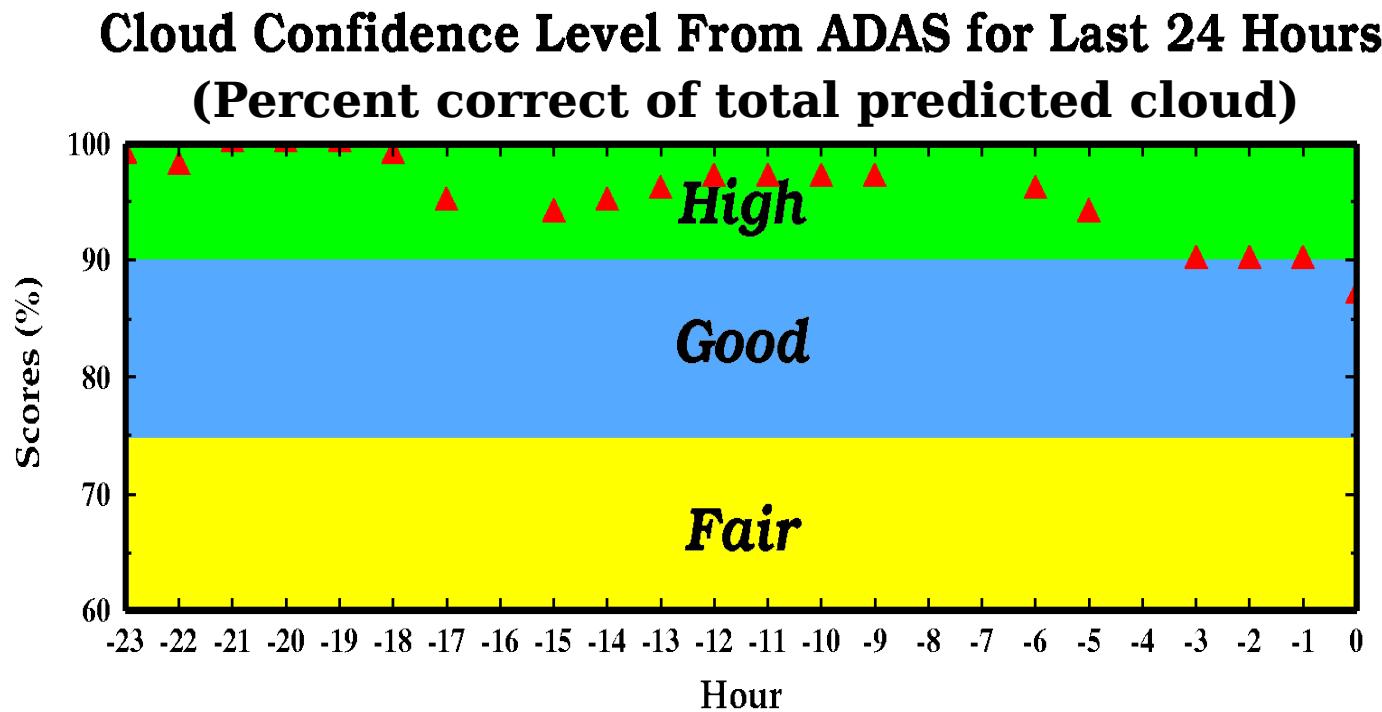
FOR THE NEXT GENERATION NAVY

**NOWCAST**

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## Example of Confidence Level from ADAS Cloud Product Verification/Monitoring System. Additional information is available to Forecasters and Developers

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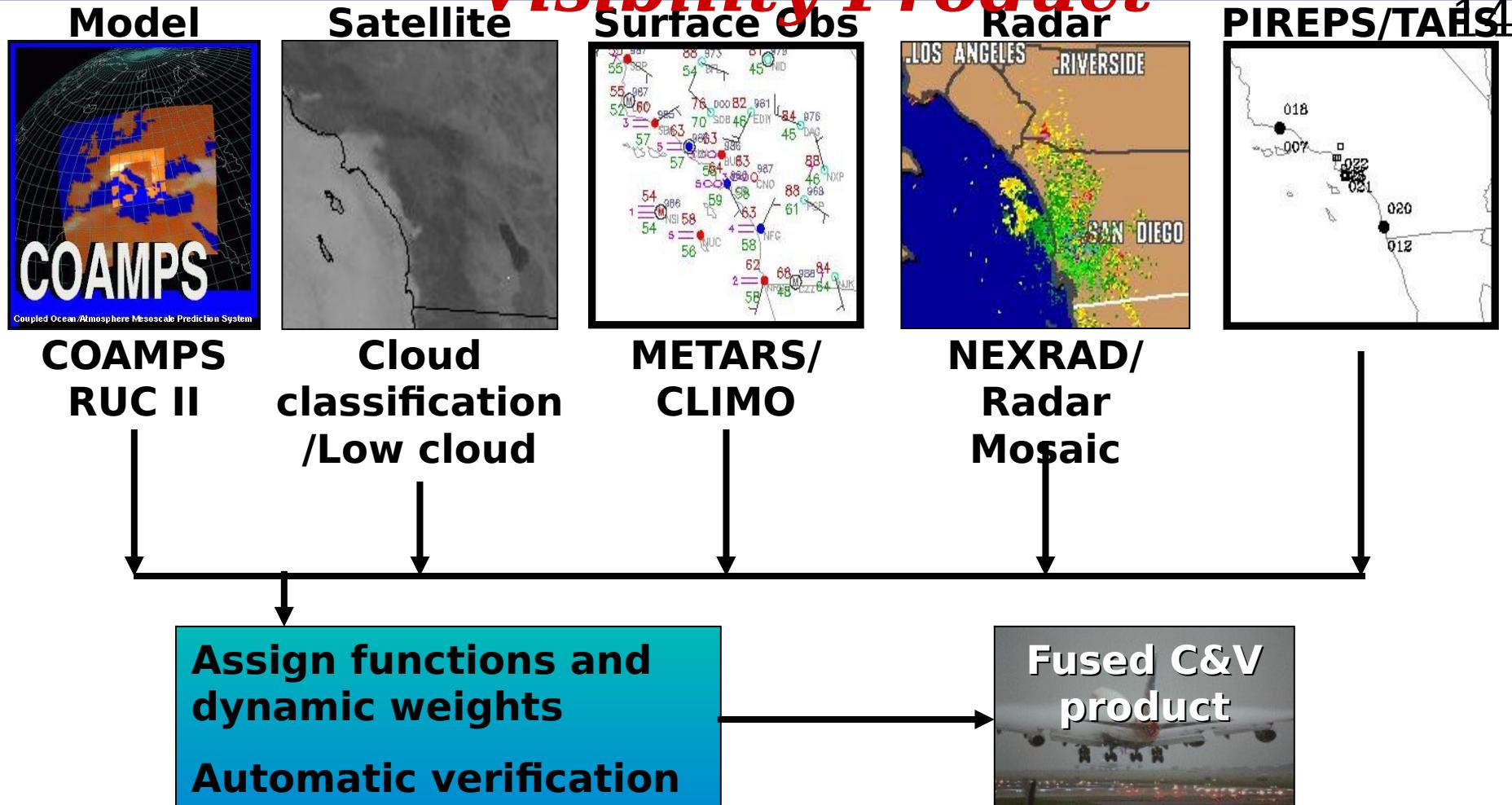


Time at T=0: 17 UTC February 20, 2001



# NCAR Fuzzy Logic Ceiling & Visibility Product

The US Navy and Marine Corps Corporate Laboratory



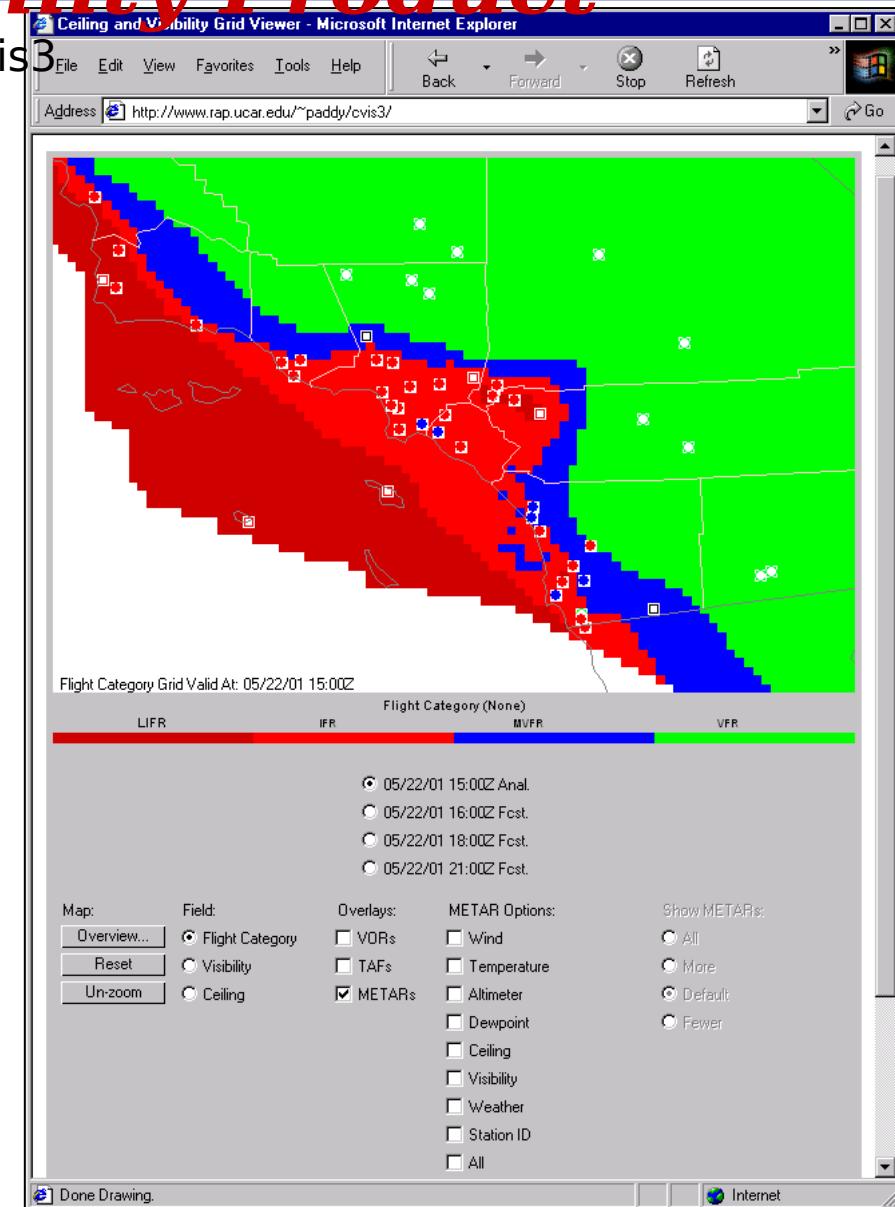
Evaluation 1 June - 31 August, 2000 at NWS Oxnard, NAWC Pt. Mugu, FAA Palmdale, NWS San Diego, and NPMOC San Diego



# NCAR Fuzzy Logic Ceiling & Visibility Product

The US Navy and Marine Corps Corporate Laboratory

<http://www.rap.ucar.edu/~paddy/cvsi3>





# Ceiling & Visibility Evaluation

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**Ceiling and Visibility Evaluation Form - Microsoft Internet Explorer**

File Edit View Favorites Tools Help Back Forward Stop Refresh Search Favorites Print Mail Address http://www.rap.ucar.edu/projects/cvis/testsurvey2.html Go

Email address: [ ] (not required)

Current Date (UTC) (mo/day/yr): [ ]

Current Time (UTC) (eg. 0900, 1000, 1100): [ ]

Please utilize surface observations and satellite data in the evaluation of this product. Surface observations can be found on the product page <http://www.rap.ucar.edu/paddy/cv3> and satellite data can be found at <http://www.rap.ucar.edu/weather/satellite>. The system provides past forecasts of C&V valid at the current analysis time. This allows for simultaneous evaluation of the analyses and forecasts being produced by the system.

1. Please indicate what site you are including in this evaluation.

[ENTIRE SOCAL DOMAIN]

2. How would you categorize southern California at this time, in terms of low ceilings and visibilities?

[1-widespread low C&V (Ceiling < 3000 ft.: Vis < 5 mi.)]

Comments: [ ]

3. What is the observed ceiling (ft) and visibility (mi) at the evaluation site? If you are evaluating the "entire SOCAL domain," please indicate the minimum observed ceiling and visibility within the domain.

Ceiling: [less than 200 ft] Visibility: [less than 0.5 mi]

4. If the ceiling is less than 3000 ft and/or visibility is less than 5 mi, what is the major cause of the low ceilings or visibilities? (e.g. marine stratus, fog, haze, etc.)

[ ]

5. If the ceiling is less than 3000 ft and/or visibility is less than 5 mi, how long has the event persisted?

less than 2 hours  2-5 hours  
 5-8 hours  8-12 hours  
 greater than 12 hours  unknown

6. Using a scale of 1-5, where 1 is poor and 5 is excellent, how would you rate the performance of the ceiling and visibility analyses at the evaluation site?

	1	2	3	4	5
Ceiling Analysis	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Visibility Analysis	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Internet

**Ceiling and Visibility Evaluation Form - Microsoft Internet Explorer**

File Edit View Favorites Tools Help Back Forward Stop Refresh Search Favorites Print Mail Address http://www.rap.ucar.edu/projects/cvis/testsurvey2.html Go

7. In what ways did the analyses from the C&V algorithm differ from the actual event in question? (Check all that apply)

	Location	Values too high	Values too low	Other	Differences were negligible
Ceiling Analysis	<input type="checkbox"/>				
Visibility Analysis	<input type="checkbox"/>				

Comments: [ ]

8. Using a scale of 1-5, where 1 is poor and 5 is excellent, how would you rate the performance of the ceiling and visibility forecasts at the evaluation site?

	1	2	3	4	5
Ceiling Forecasts	<input checked="" type="radio"/>				
Visibility Forecasts	<input checked="" type="radio"/>				

9. In what ways did the forecasts from the C&V algorithm differ from the actual event in question? (Check all that apply)

	Location	over-forecast (values too high)	under-forecast (values too low)	Timing	Other	Differences were negligible
1-hr. ceiling forecast	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3-hr. ceiling forecast	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6-hr. ceiling forecast	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1-hr. visibility forecast	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3-hr. visibility forecast	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6-hr. visibility forecast	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments: [ ]

10. Please list any trends (e.g., algorithm over-forecasts C&V, under-forecasts C&V, etc.) that you have identified.

[ ]

Other comments:

[ ]

Internet



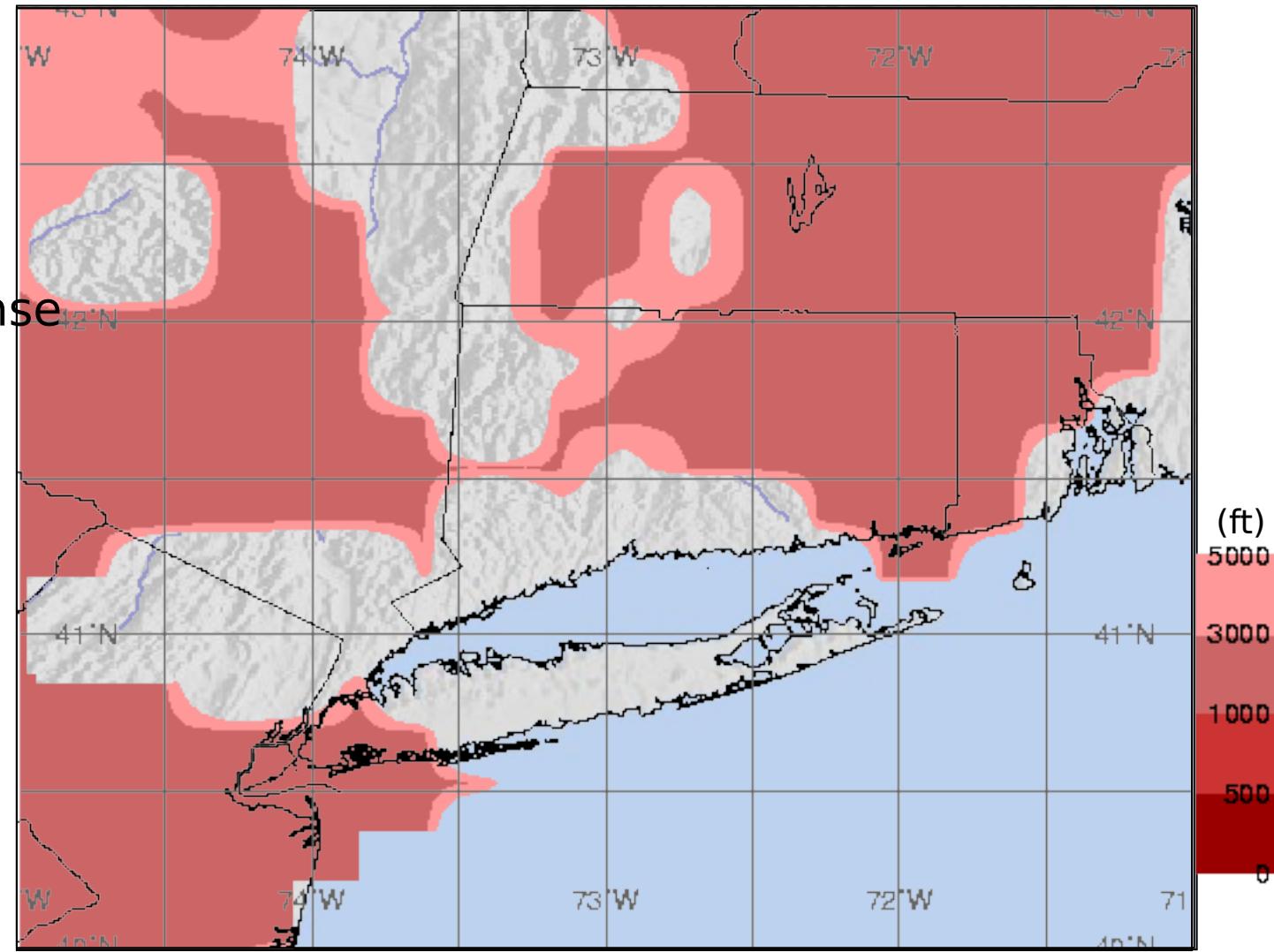
# Nowcast Web-Based Ceiling Height Layered Product Design

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## Applicability

- STW
  - TACAIR
  - TLAM
- CVN Case Wx
- Area Air Defense
- Heli Aviation
  - ASW
  - AMW
  - AMCM
  - OTHT
  - Logistics



Ceiling, visibility or flight category layered product

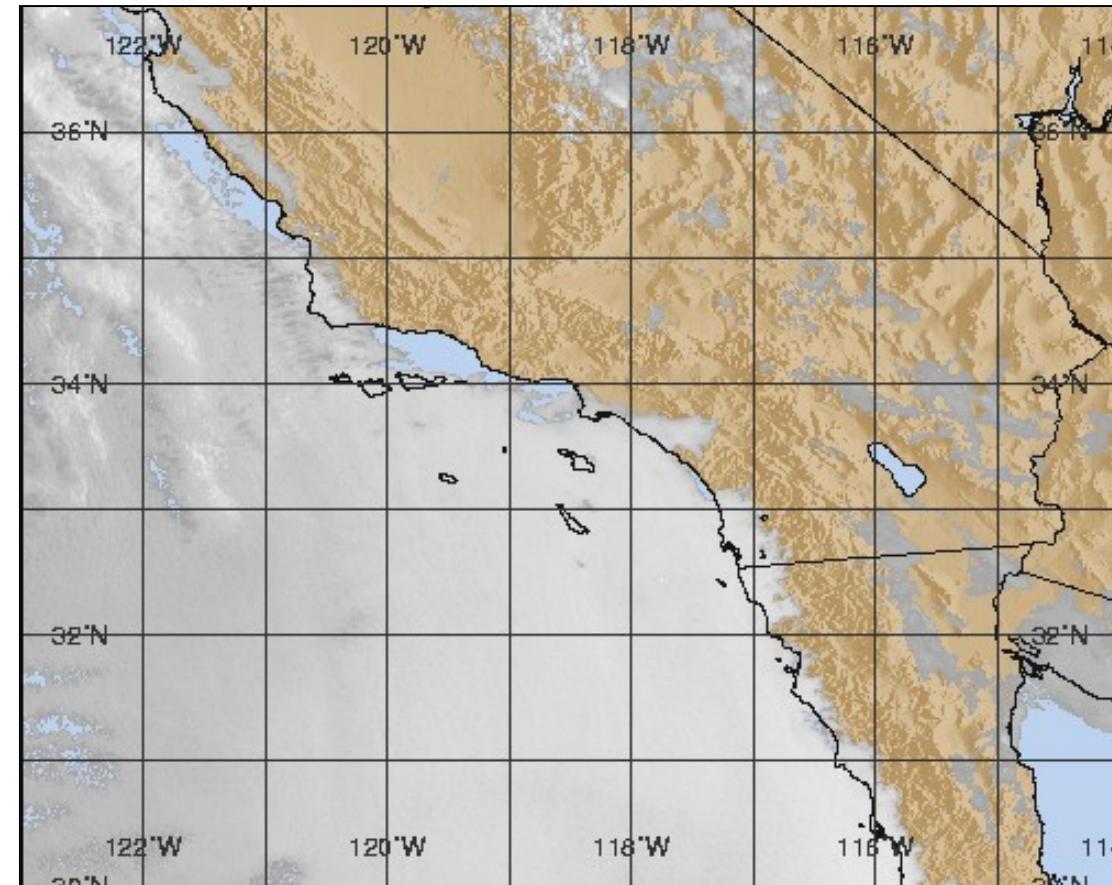


# Satellite Visible and IR Data

The US Navy and Marine Corps Corporate Laboratory

## Applicability

- CVN Case Wx
- Missile Launches
- EM/EO
  - Surveillance
  - FC Radar
  - Comms
  - Ducting
  - I&W
- Area Air Defense
  - Helo Aviation
  - ASW
  - AMW
  - AMCM
  - OTHT
  - Logistics
- Navigation



- Data available from server on NRL FMQ-17 (Terascan) system
- 15 min update rate

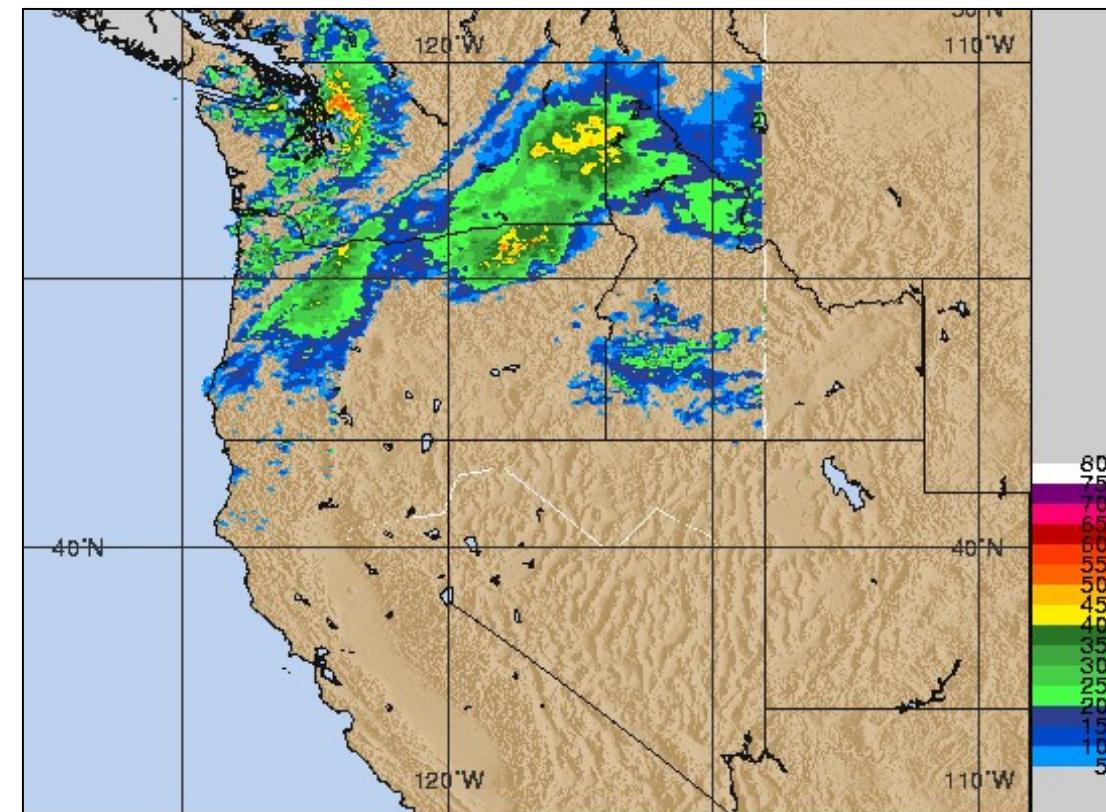


# NEXRAD Radar Data

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## Applicability

- CVN Case Wx
- Missile Launches
- EM/EO
  - Surveillance
  - FC Radar
  - Comms
  - Ducting
  - I&W
- Area Air Defense
  - Helo Aviation
  - ASW
  - AMW
  - AMCM
  - OTHT
  - Logistics
- Navigation



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- Data available from NOAAPort and on NOAA anonymous ftp site
- Example composite of nine radars
- 10 min update rate

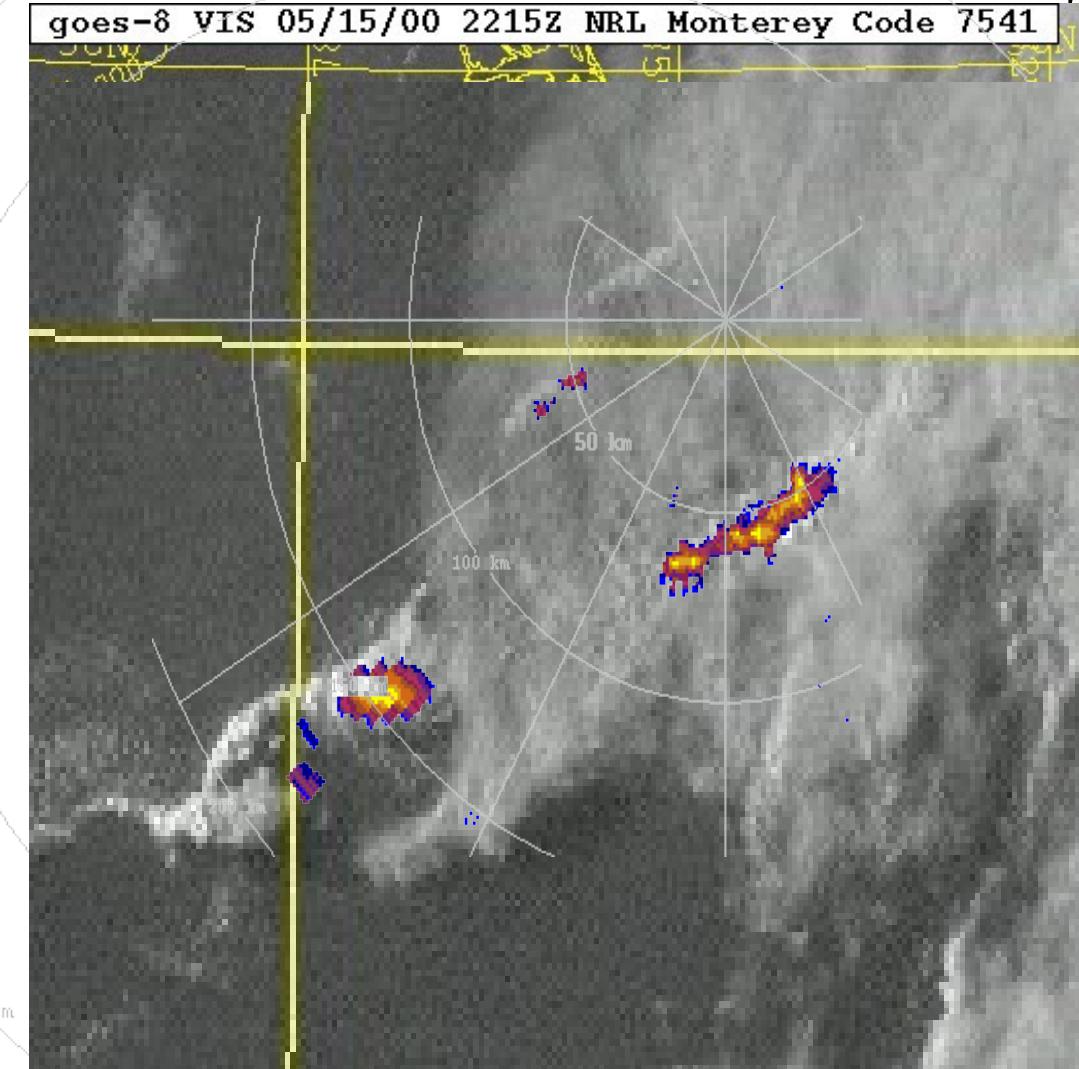


# Radar Combined with Satellite

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## Applicability

- CVN Case Wx
- Missile Launches
- EM/EO
  - Surveillance
  - FC Radar
  - Comms
  - Ducting
  - I&W
- Area Air Defense
  - Helo Aviation
  - ASW
  - AMW
  - AMCM
  - OTHT
  - Logistics
- Navigation Safety



**Embedded thunderstorms  
approaching the battlegroup**



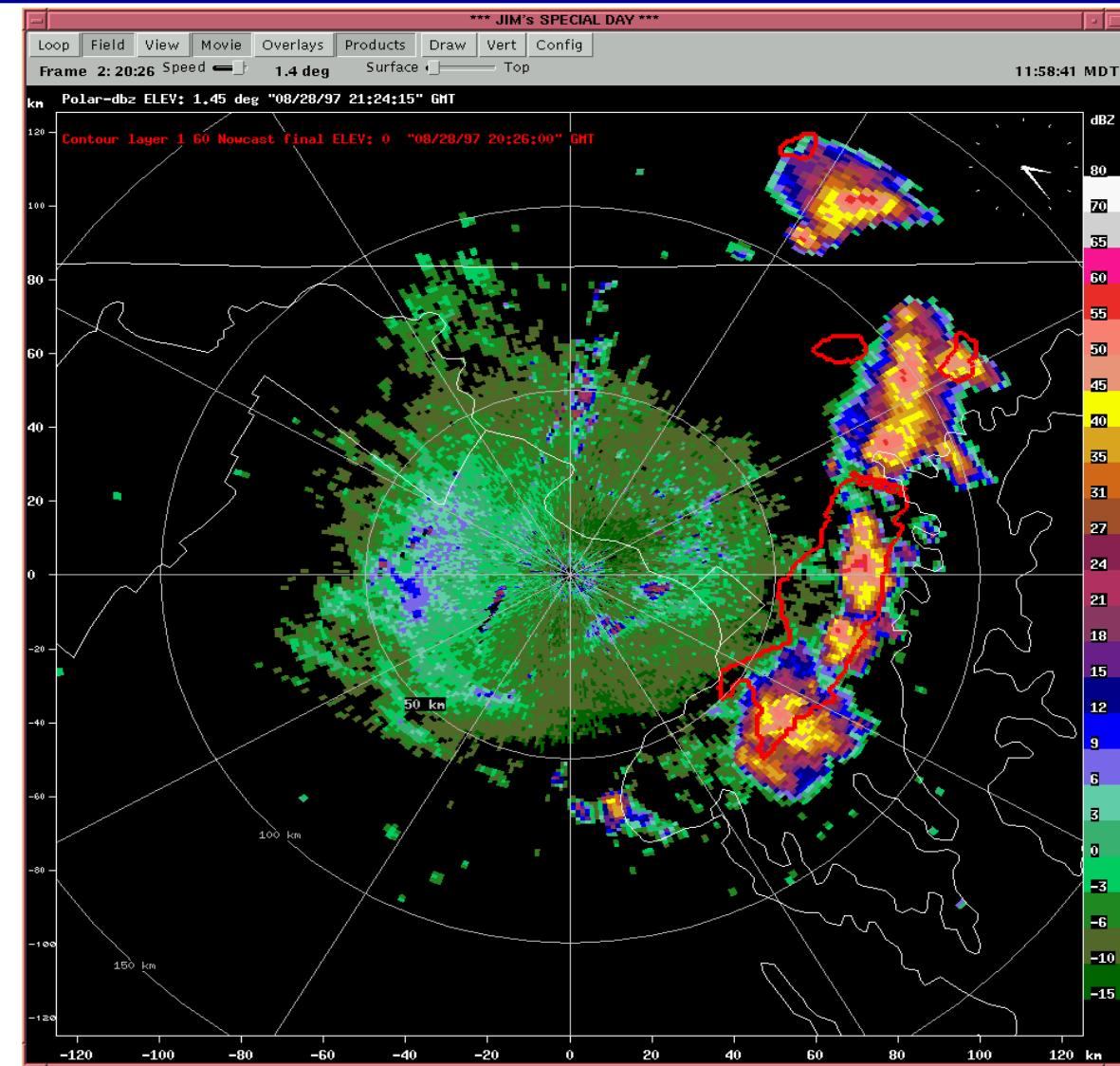
# Thunderstorm Autonowcaster

The US Navy and Marine Corps Corporate Laboratory

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## Applicability

- CVN Case Wx
- Missile Launches
- EM/EO
  - Surveillance
  - FC Radar
  - Comms
  - Ducting
  - I&W
- Area Air Defense
  - Heli Aviation
  - ASW
  - AMW
  - AMCM
  - OTHT
  - Logistics
- Navigation



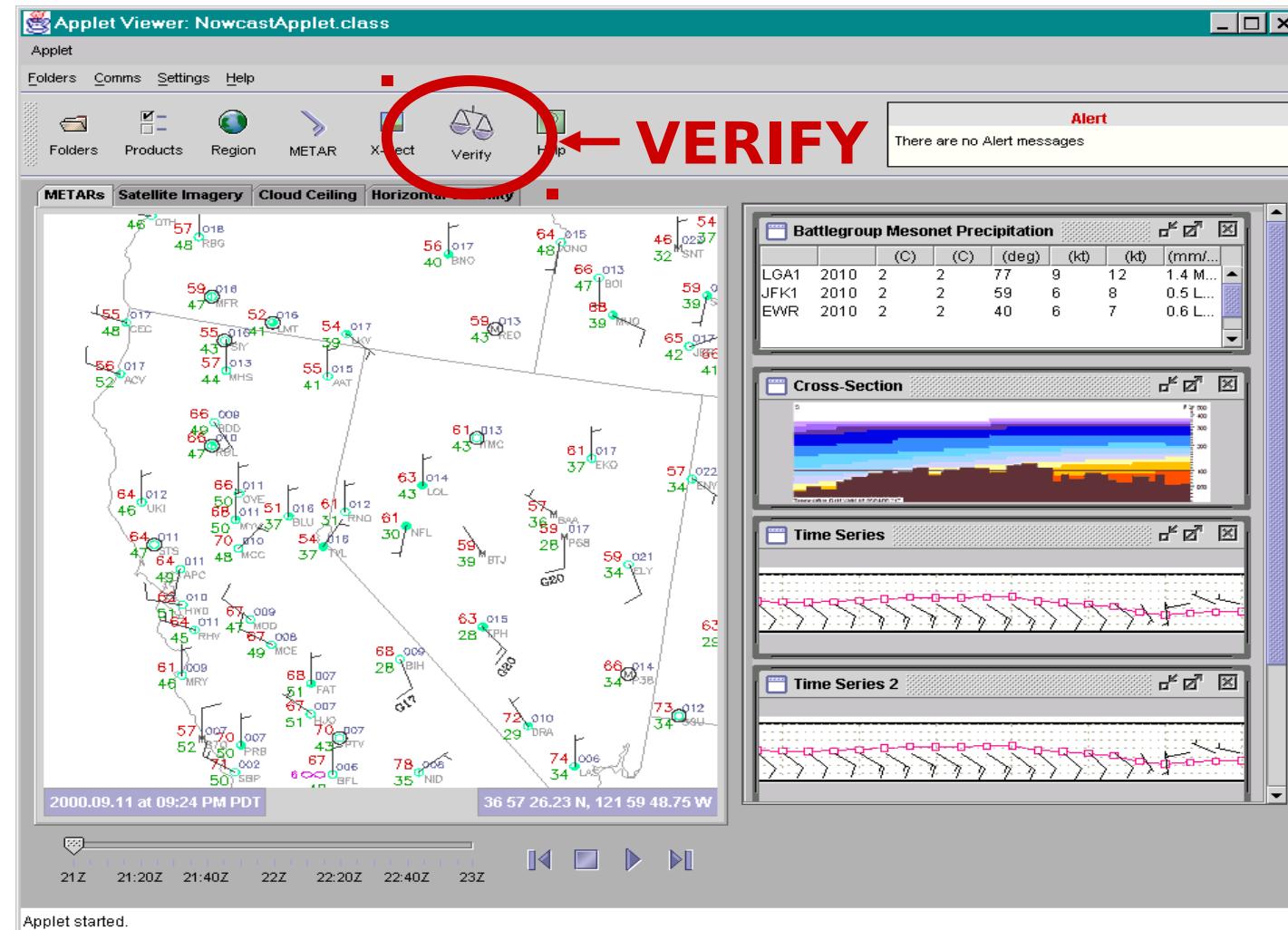
One-hour forecast (red) and automatic verification



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**Ultimate Goal: Each Nowcast product will have a verification product and running “confidence level” associated with it**



# Error Threshold Monitoring using Stoplight Display

The US Navy and Marine Corps Corporate Laboratory

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## NOWCAST VERIFICATION

### COAMPS

Confidence Level for Last 6 Hours: Friday 21Z 18 MAY 2001

Product	Error Threshold	T - 5h	T - 4h	T - 3h	T - 2h	T - 1h	NOW
Wind Speed	5 kt	CAUTION	CAUTION	CAUTION	MISSING	CAUTION	CAUTION
Wind Direction	90 deg	WARNING	WARNING	WARNING	MISSING	WARNING	WARNING
Temperature	10 deg C	CAUTION	CAUTION	CAUTION	MISSING	CAUTION	CAUTION
Relative Humidity	20 percent	WARNING	WARNING	WARNING	MISSING	WARNING	WARNING
Dewpoint Temperature	10 deg C	WARNING	WARNING	WARNING	MISSING	OKAY	CAUTION

RED: Warning (>2X), YELLOW: Caution (>1X), GREEN: Okay (<1X), GRAY: Missing

- All products within a user's folder
- All the stations within a product, or a group of selected stations within a specified area of interest, or for one specific station
- Web-based, drill down capability
  - Color coded difference maps with station plots
  - Historical time series; Vertical profiles



# FOR THE NEXT GENERATION NAVY Nowcast

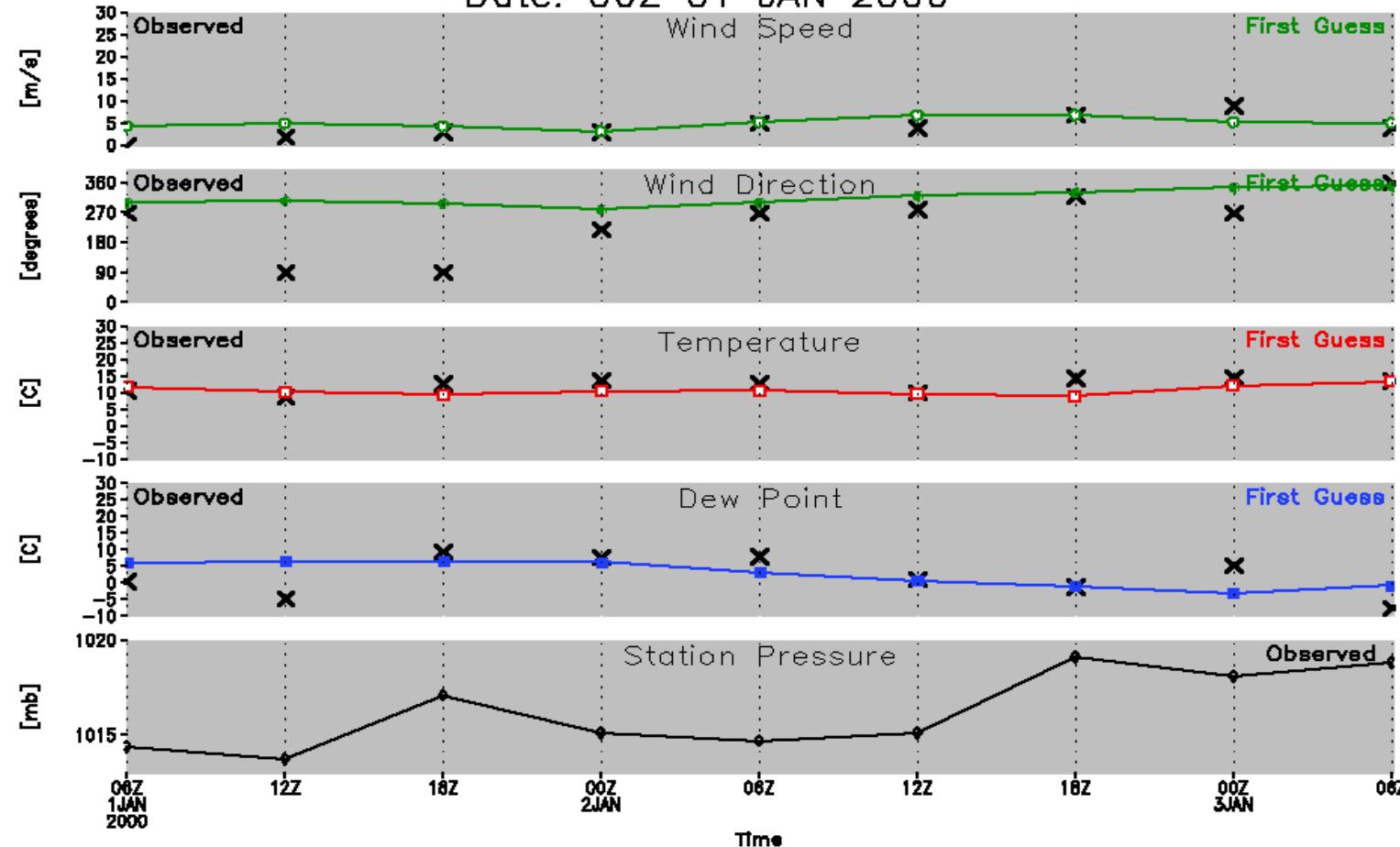
The US Navy and Marine Corps Corporate Laboratory

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Station: 72265 – Last 2 Days

Lon = 257.78E Lat = 31.95N

Date: 06Z 01 JAN 2000



Time series for multiple parameters

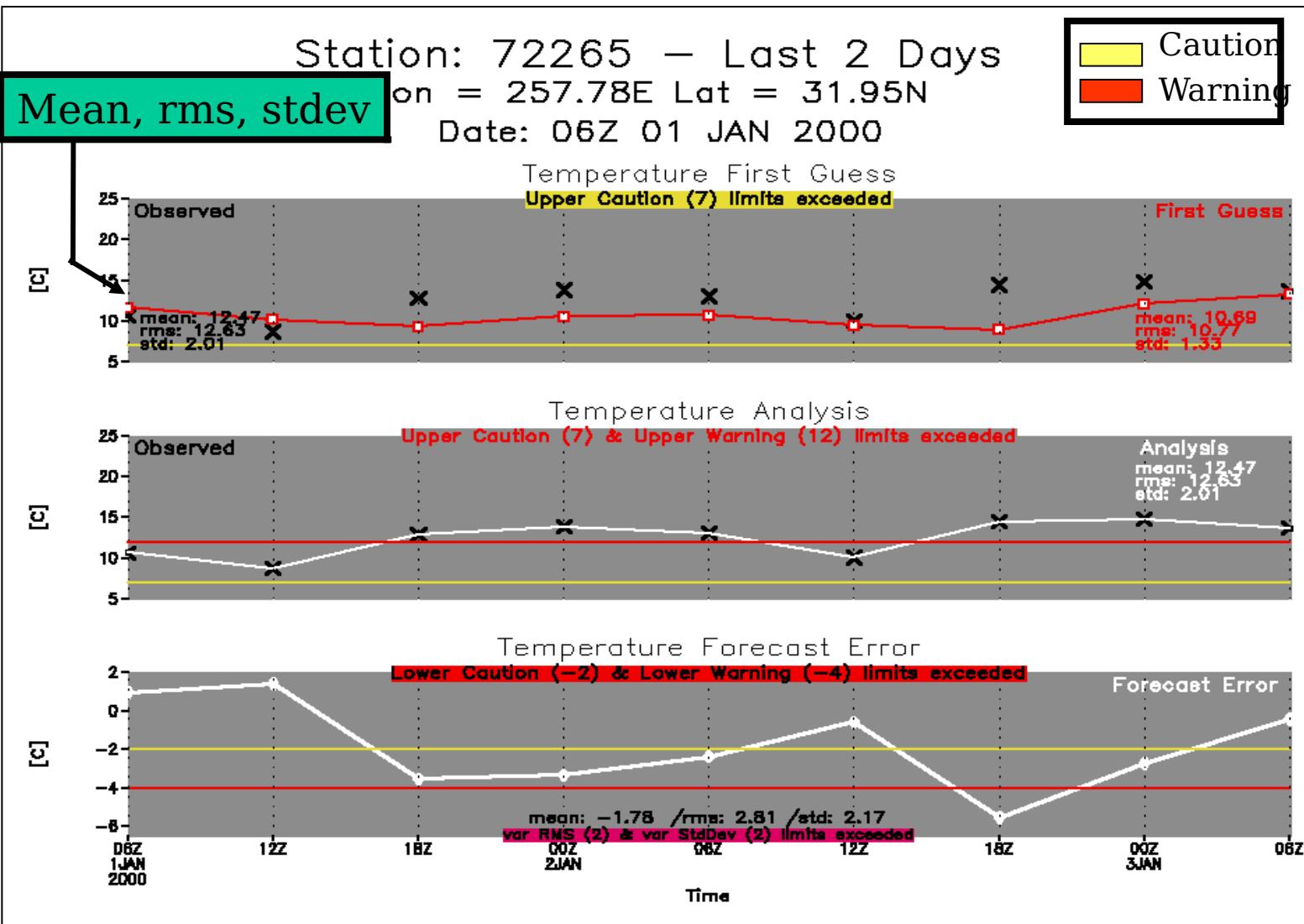


# FOR THE NEXT GENERATION NAVY

## NOWCAST

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Time series with statistics and threshold alerts



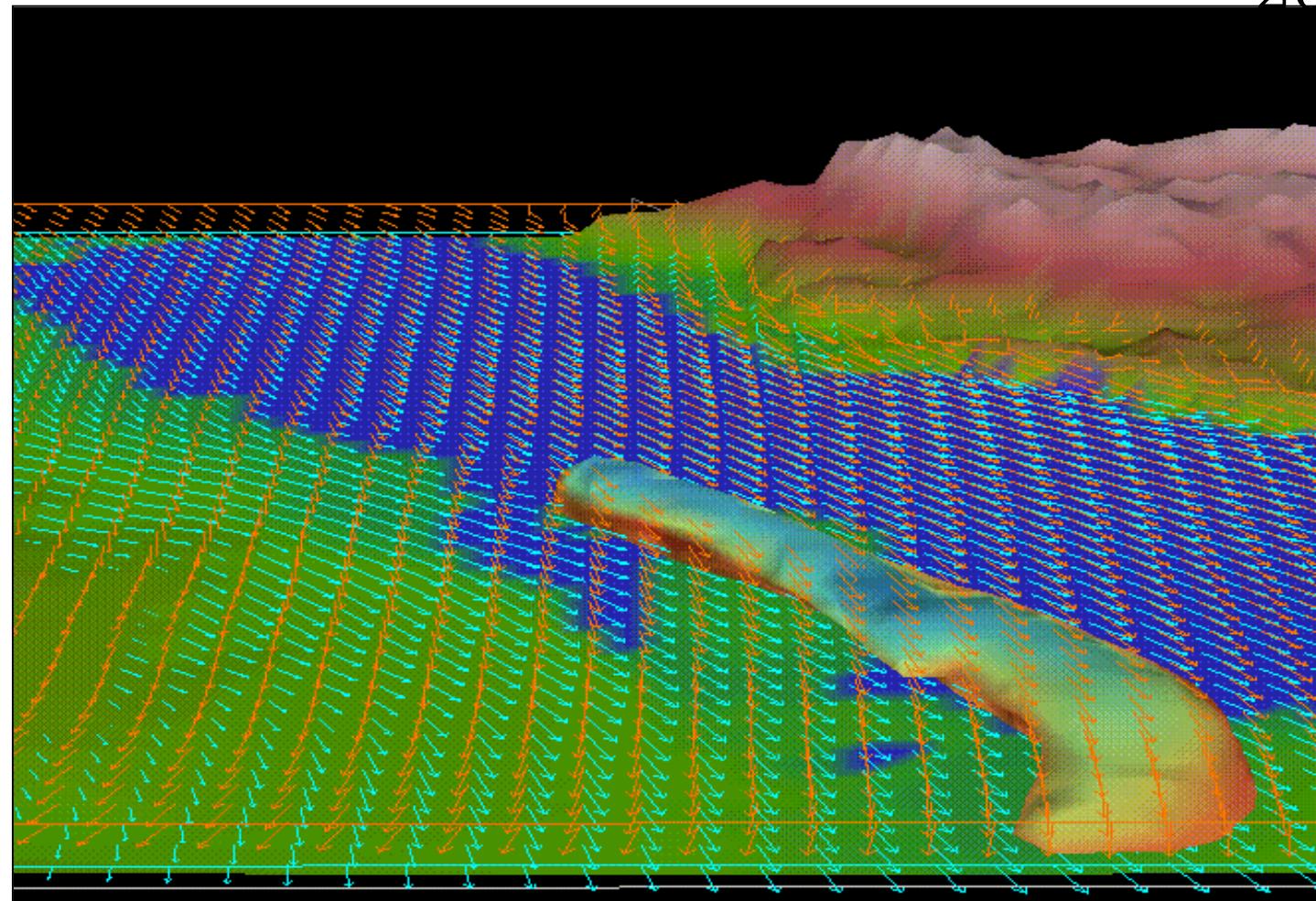
# *High-Resolution Winds Drive Chem/Bio Models*

The US Navy and Marine Corps Corporate Laboratory

2.6

## Applicability

- CVN Launch and Recovery
- STW
- Missile Launch
- Heli Aviation
  - ASW
  - AMW
  - AMCM
  - OTHT
  - Logistics
- WMD
  - JWARN



**Proposal submitted to Joint Science and Technology Panel for Chemical and Biological Defense**



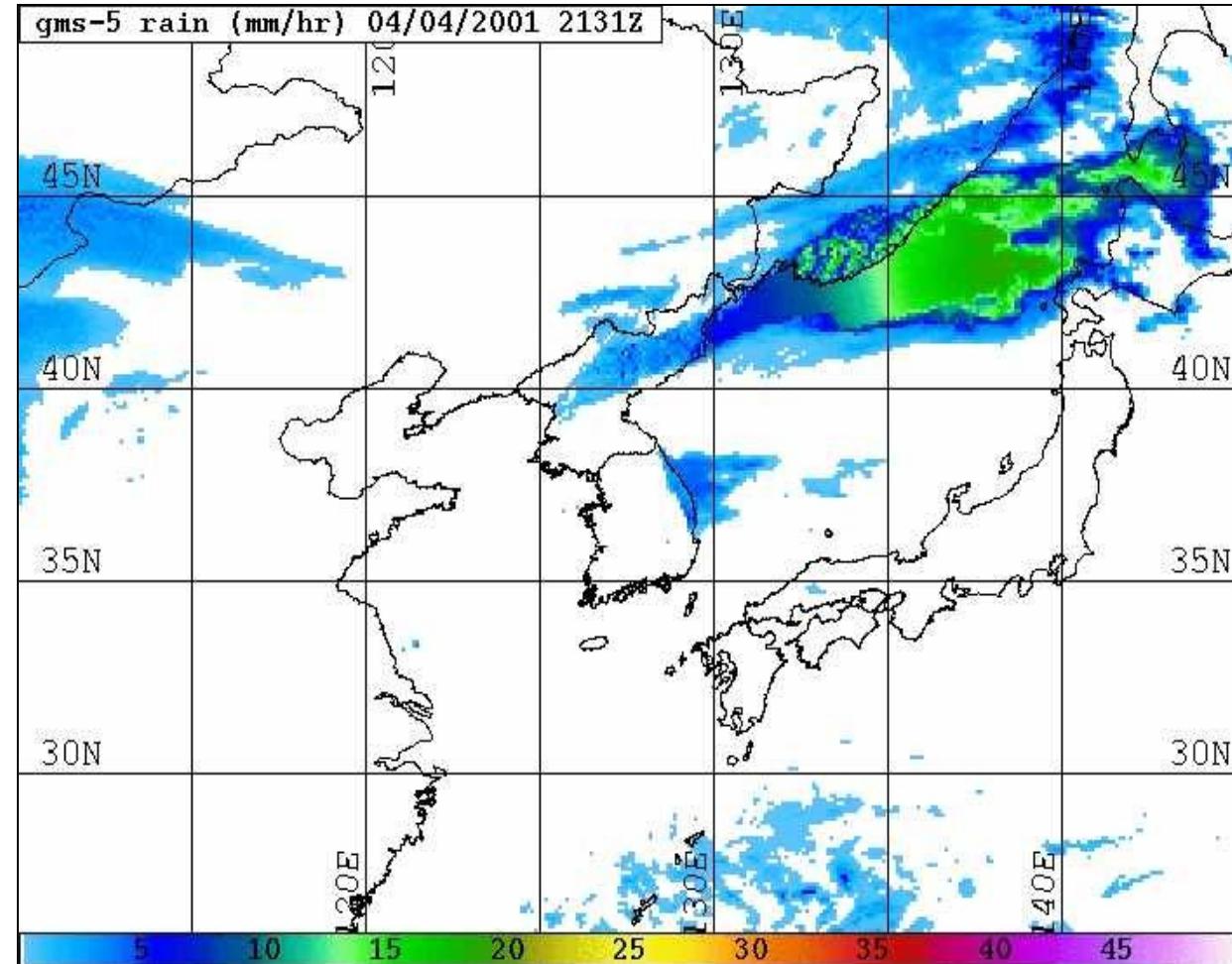
# Satellite Target Area Rain Rate Display

The US Navy and Marine Corps Corporate Laboratory

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## Applicability

- Ship To Objective Maneuver (STOM)
- Logistics Over The Shore (LOTS)
- Trafficability



**Continuous satellite rain rates may be improved with TEP data**



# Meteogram Time-Height Display

## Applies to a Specific Target Location

The US Navy and Marine Corps Corporate Laboratory

### Applicability

- STW
  - Tactics
  - 
  - Weapons Selection
  - BDA
- EM/EO
- C4ISR
- SOF

**Wind Barbs (kts)  
Temperature (F)  
RH > 70%  
Freezing level**

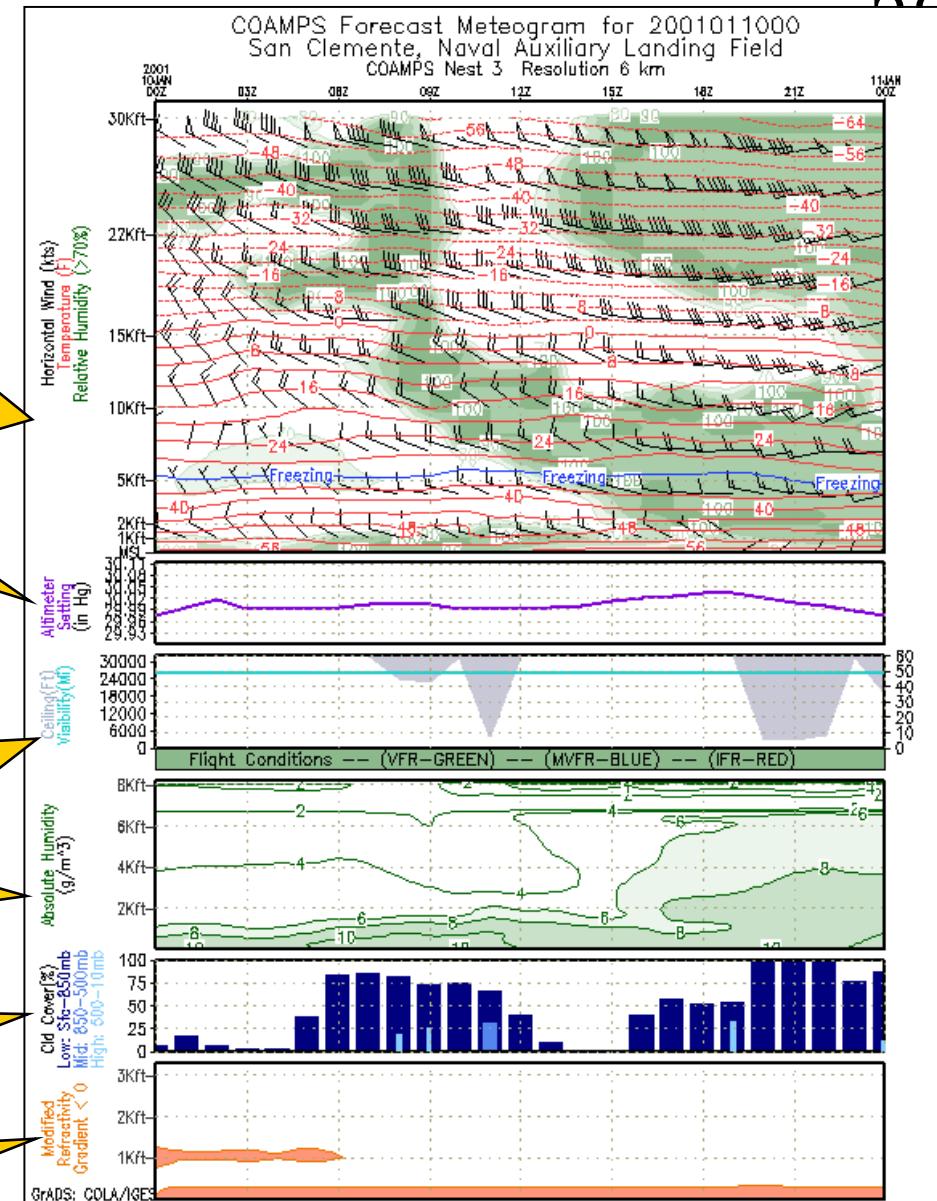
**Altimeter Setting (in Hg)**

**Ceiling Height (ft)  
Visibility (mi)  
Flight Category**

**Absolute Humidity  
(g/m\*\*3)**

**Layer Cloud Coverage (%)**

**Trapping Layer Altitudes  
(ft)**





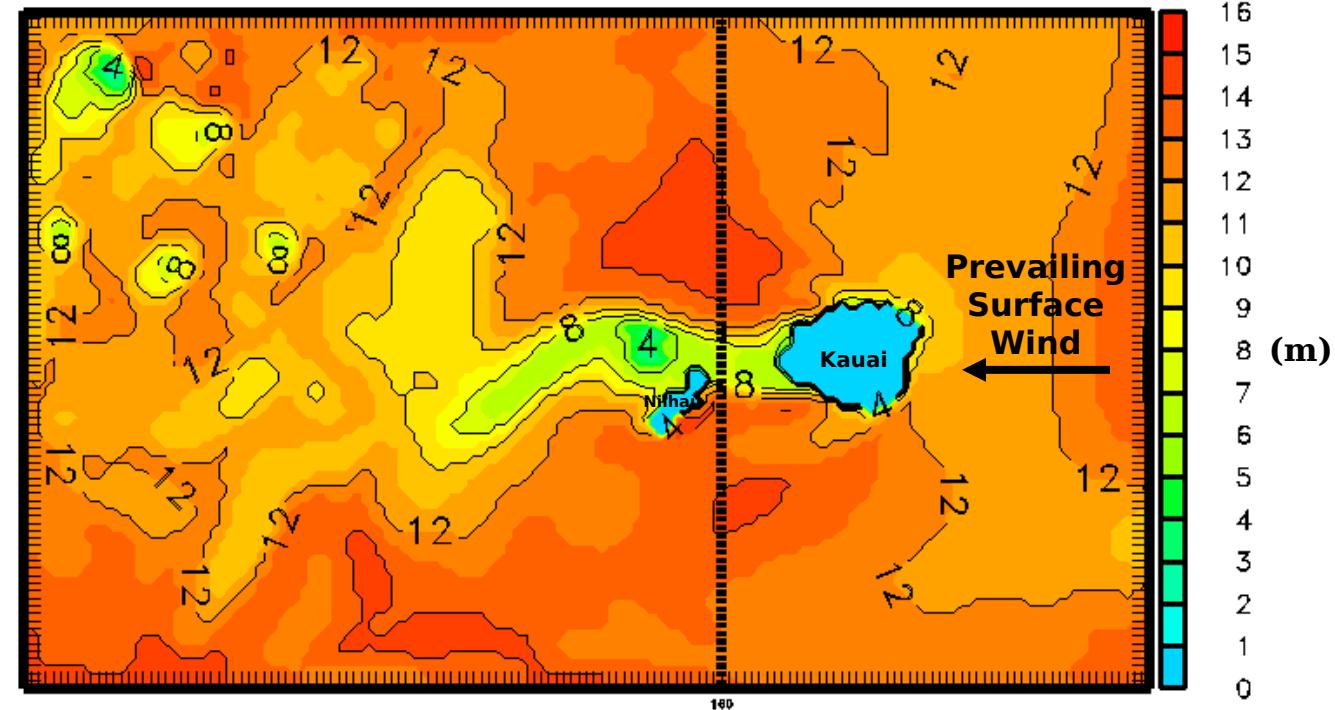
# Evaporation Duct Height

The US Navy and Marine Corps Corporate Laboratory

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## Applicability

- EM
  - SPY FTR
  - Surveillance
  - I&W
- Area Air Defens
  - Low Flyer
- Comms
- ESM



**Modeled evaporation duct height in the lee of Kauai**

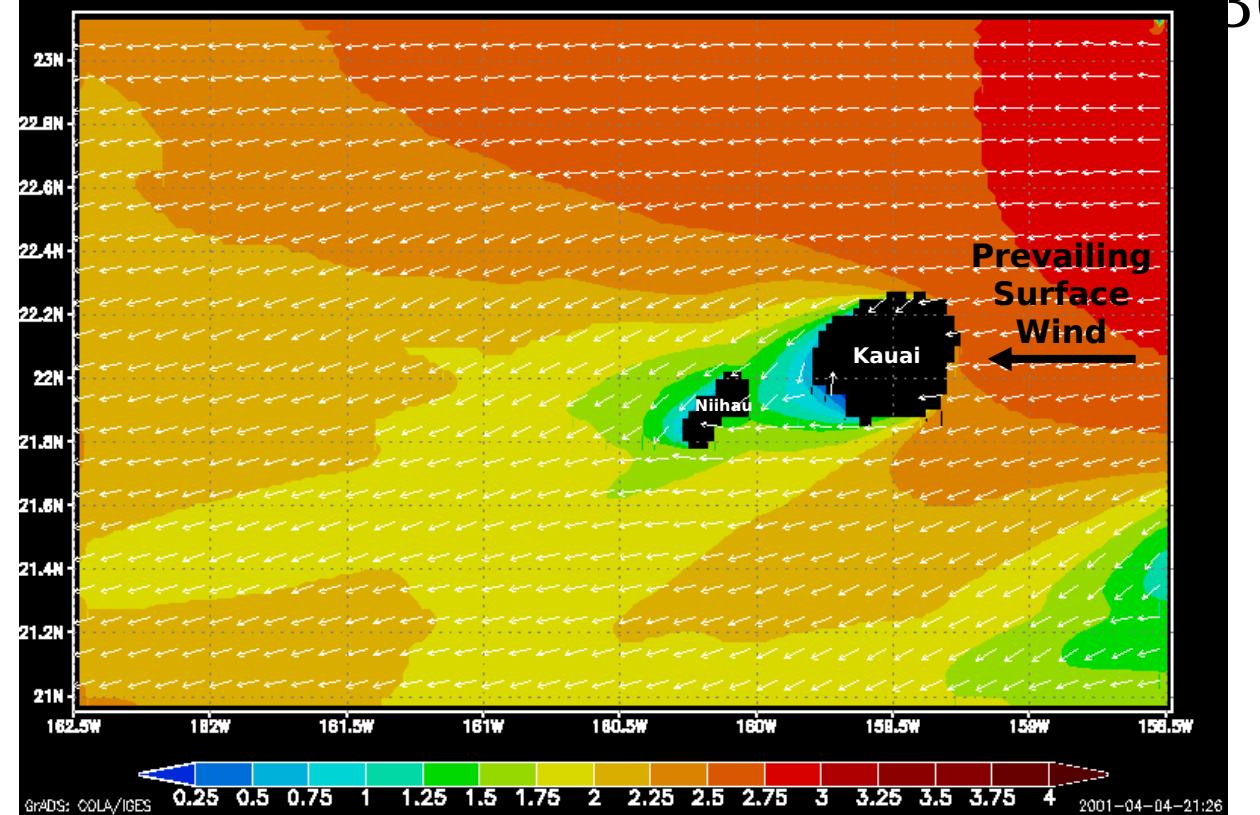


# Wave Height and Direction

The US Navy and Marine Corps Corporate Laboratory

## Applicability

- Sea State
  - Well Deck Ops
  - Small Boat Ops
  - SOF
  - EOD
  - AAV
  - Landing Craft
  - Unrep
- ASW Ops
  - Heli
  - Tail
  - Acoustic Sensors
  - Non-Acoustic Sensors
- Missile Launches



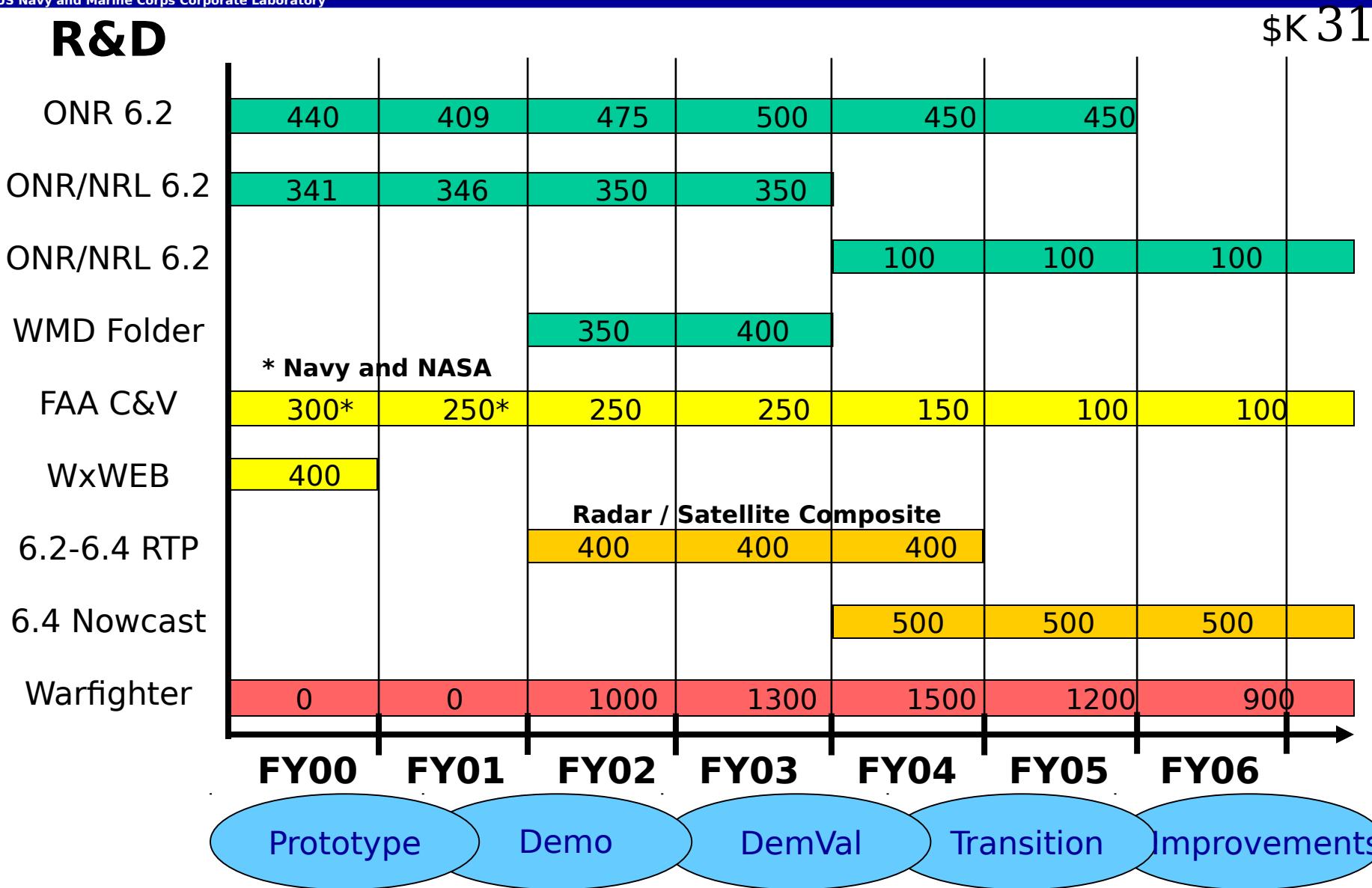
## Wave height and direction around Kauai



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## R&D





# FOR THE NEXT GENERATION NAVY Nowcast

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**Links to:**  
**News**  
**FAQ**  
**IPT Forum**  
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NRL Monterey Marine Meteorology Division (Code 7500)

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Approved for public release by:  
[Dr. Merilees](#), Superintendent

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Last Updated: 19FEB01

Satellite Winds Cloud Imagery Satellite Rain Rate TEP Weather Radar

UAV Weather Data NOWCAST 3D "snapshot" of weather around the battlegroup and target areas

Target Area Weather Data Weather Observations Dust and Pollution Data

**Nowcast for the Next Generation Navy**

Nowcast for the Next Generation Navy is a project at the Naval Research Laboratory (NRL) to develop a nowcasting system (called Nowcast) for the Navy. The development of the Nowcast system is sponsored by the Office of Naval Research (ONR), with contributions from the Oceanographer of the Navy (Space and Naval Warfare Systems Command and the Commander, Naval Meteorology and Oceanography Command), the National Aeronautics and Space Administration (NASA), and the Federal Aviation Administration (FAA).

**The complexity of the naval battlespace necessitates the automated fusion of environmental information to maintain a consistent database of the Virtual Natural Environment (VNE). The battlegroup of today has limited capability to sample the environment, has no capability to efficiently fuse the sparse information that is available, nor does it have the ability to share a common, consistent representation of the VNE among its components.**

The Nowcast system is being developed with input from an Integrated Product Team (IPT) to provide the organic battlegroup VNE database and end-user products based on the data. The Nowcast system is an enterprise-class, network-centric, data fusion system that will allow the forward-deployed battleship to automatically and continuously fuse environmental data from available sources to characterize the battlespace environment.

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